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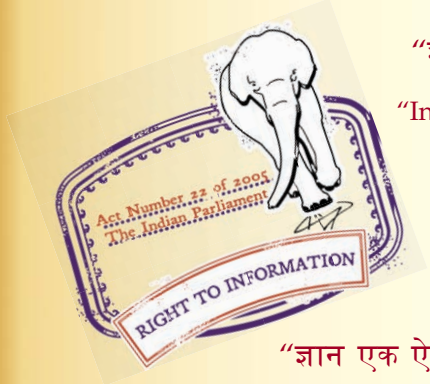

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"Knowledge is such a treasure which cannot be stolen"

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Indian Standard

SPECIFICATION FOR ELECTRICAL RELAYS

PART 2 INSULATION TESTS

UDC 621·318·5 : 621·317·333

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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Gr 6

January 1988

Indian Standard

SPECIFICATION FOR ELECTRICAL RELAYS

PART 2 INSULATION TESTS

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SPECIFICATION FOR ELECTRICAL RELAYS

PART 2 INSULATION TESTS

0. FOREWORD

0.1 This Indian Standard (Part 2) was adopted by the Indian Standards Institution on 3 December 1986, after the draft finalized by the Relays Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard prescribes requirements for voltage tests, including impulse withstand test and insulation resistance test for electrical relays in general. A separate series of standards is being brought out for electrical relays for power system protection. Specific/supplement requirements for protection relays will be covered in the appropriate parts of that series of standards.

0.3 For each type of electrical relay, the degree of severity of test requirements is intended to be stated in the individual standard on that type of relay. In case the degree of severity is not mentioned, guidance given in Appendices A and C should be followed. Appendix B provides guidance for selection of degrees of severity for clearances and creepage distances and other aspects related to insulation of electrical relays.

0.4 Additional requirements may be necessary for particular types of relays, such as static relays and will be stated in the relevant standard of the electrical relays.

0.5 In the preparation of this standard, assistance has been derived from IEC Pub 255-5 (1977) 'Electrical Relays, Part 5: Insulation tests for electrical relays', issued by the International Electrotechnical Commission.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard (Part 2) specifies general requirements for the insulation of relays used in electrical field.

1.2 This standard also applies to associated ancilliary devices such as shunts, series resistors, transformers, used and tested together with electrical relays, except where the device is covered by a separate Indian Standard.

2. TERMINOLOGY

2.1 For the purpose of this standard, in addition to those given in IS : 1885 (Part 9)-1986*, the following definitions shall apply.

2.2 Live Part — Any conductor or conductive part which is at voltage in normal use.

2.3 Exposed Conductive Part — A conductive part which can readily be touched and which is not a live part but which may become live under fault conditions.

NOTE 1 — For relays which are not enclosed, the frame, the fixing devices etc, form the exposed conductive parts.

NOTE 2 — For relays which are enclosed, the conductive parts which are accessible when the relay is mounted in its normal position of use, including those of its fixing surface, form the exposed conductive parts. Small parts such as inscription plates, screws and reviets which are isolated from the circuits are not taken into consideration.

2.4 Rated Insulation Voltage (of a Relay Circuit) — The value of voltage which conventionally designates a relay circuit and to which dielectric tests, clearances and creepage distances are referred.

2.5 Clearance — The distance between two conductive parts along a thread stretched or the shortest path between these two conductive parts.

2.6 Creepage Distance — The shortest distance between two conductive parts along the surfaee of an insulating material or along the joint between two insulating bodies.

2.7 Dielectric Test — A test of short duration which consists of applying a specified voltage to the insulation to prove that it is in accordance with the rated insulation voltage of the circuit, as stated by the manufacturer.

2.8 Impulse Voltage Test — A test which consists of applying a specified impulse voltage to the insulation to prove the ability of the relay to withstand, without damage, overvoltages of very high values and very short durations.

*Electrotechnical vocabulary: Part 9 Electrical relays (*first revision*).

3. ASSESSMENT OF RATED INSULATION VOLTAGES

3.1 Standard Values of Rated Insulation Voltages — The rated insulation voltages of one or all circuits of a relay shall be chosen from the following series of values:

30, 60, 127, 250, 380, 500, 660, 750 and 1 000 V.

3.2 Assessment of Rated Insulation Voltage — The rated insulation voltage shall be assessed as follows:

a) For insulation between live parts and exposed conductive parts: not less than the rated voltage of circuit under consideration;

b) For insulation between the parts of one circuit, except as provided in item **3.2**(e) below : not less than the rated voltage of the circuit under consideration;

c) For insulation between the parts of two independent circuits; the rated insulation voltage shall be at least equal to the higher rated voltage of these circuits;

d) For insulation of circuits to be energized directly *via* instrument transformermers, at least 250 V;

e) For gap between open contacts: unless otherwise agreed to between the manufacturer and the user, no rated insulation voltage shall be specified; and

f) For circuits of a relay having rated voltages exceeding 1 000 V : no rated insulation voltage is specified and tests for such circuits shall be as agreed to between the manufacturer and the user.

3.3 Unless otherwise specified in the relevant standard on electrical relay, the rated insulation voltage, as determined in **3.2** shall be declared, by the manufacturer. If the rated insulation voltage is higher than the circuit rated voltage [*see* **3.2**(a)], the relay may be operated at this higher potential with respect to earth.

3.4 For relays which are used in equipment that is not subject to safety requirements, zero rated insulation voltage may be declared, provided that this is specified in the relevant standard on electrical relay. Such relays shall be marked with the symbol of Table 2.

NOTE — Zero rated insulation voltage denotes that the relay is not subjected to the insulation test requirements.

4. GENERAL REQUIREMENTS REGARDING INSULATION TESTS

4.1 Insulation tests include dielectric (steady-state voltage) (*see* **5**), measurement of insulation resistance (*see* **6**), and impulse voltage tests (*see* **7**).

4.1.1 These tests, which are type tests, acceptance tests or routine tests as indicated in this standard, are applicable to relays in a new condition (*see also* **5.6**).

4.2 Unless otherwise specified in the relevant relay standard, the atmospheric conditions for insulation tests shall not be outside the following ranges:

a) Ambient air temperature: 15 to 35°C,

b) Relative humidity: 45 to 75 percent, and

c) Air pressure: $86 \cdot 10^3$ to $106 \cdot 10^3$ Pa (860 to 1 060 mbar).

4.2.1 The tests are to be applied to the relays in a dry condition and without self-heating.

4.3 Insulation tests shall be performed:

a) Between each circuit and the exposed conductive parts, the terminals of each independent circuit being connected together;

b) Between independent circuits, the terminals of each independent circuit being connected together; and

c) When specified, between the terminals of a given circuit (applicable only to impulse voltage tests—*see* **7**); this condition will be specified, if necessary, in the relevant relay standard and applies also to static relays in general.

4.3.1 Unless obvious, the independent circuits are those which are so described by the manufacturer.

4.3.2 Further, by agreement between the manufacturer and the user, the insulation of open-contact circuits may be tested.

4.3.3 Circuits having the same rated insulation voltage may be connected together when being tested to the exposed conductive parts. The test voltage shall be applied directly to the terminals. For relays with an insulating enclosure, the exposed conductive parts shall be represented by a metal foil covering the whole enclosure except the terminals around which a suitable gap shall be left so as to avoid flashover to the terminals. Insulation tests requiring this metal foil shall be performed as type tests only.

5. DIELECTRIC TESTS

5.1 General — Dielectric (steady-state voltage) tests shall be performed as type, acceptance and routine tests, unless otherwise specified in the relevant eleetrical relay standard.

5.2 Value of Test Voltage — Dielectric tests shall be made by applying the voltage given in Table 1 unless otherwise specified in **5.2.1**, **5.2.2** and **5.2.3** The test voltage series shall be as specified in the relevant electrical relay standard. If not specified, the guidance given in Appendix A should

be followed. Where rated voltage has a value different from rated insulation voltage, the voltage value corresponding to next higher rated insulation voltage from Table 1 shall be chosen.

5.2.1 For circuits to be energized directly *via* instrument transformers, the test voltage shall not be less than 2 kV.

5.2.2 When testing between two circuits which are intended to be always at the same potential (for example, directly connected to the same phase), the test voltage shall be reduced to 500 V or twice the rated insulation voltage, whichever is higher.

5.2.3 When by agreement between the manufacturer and the user, a dielectric test between open contacts is to be performed, the value of the test voltage shall also be agreed.

5.3 Test Voltage Source — The test voltage source shall be such that, when applying half the specified value to the relay under test, the voltage drop observed is less than 10 percent. The source voltage shall be verified with an accuracy better than 5 percent. The test voltage shall be substantially sinusoidal and at a frequency between 45 and 65 Hz. However, by agreement, tests may alternatively be performed with a dc voltage, the value of which shall be 1·4 times of that given in Table 1.

TABLE 1 DIELECTRIC TEST VOLTAGES

(*Clauses* 5.2, 5.3 *and* 5.4.1)

Rated Insulation Voltage	Test Voltage		
	Series A	Series B	Series C
V	kV	kV	kV
(1)	(2)	(3)	(4)
30	0·5	0·5	1·0
60	0·5	1·0	1·0
127	0·5	1·0	1·5
250	1·0	1·5	2·0
380	1·0	1·5	2·5
500	1·5	2·0	2·5
660	1·5	2·5	3·0
750	1·5	3·0	3·0
1 000	2·0	3·0	3·0

5.4 Test Method — The open-circuit voltage of the testing equipment is initially set to not more than 50 percent of the specified voltage. It is then applied to the relay under test. Form this initial value, the test voltage shall be raised to the specified value in such a manner that no appreciable

transients occur and maintained for 1 minute. It shall then be reduced smoothly to zero as rapidly as possible.

5.4.1 For acceptance and routine tests, and unless otherwise agreed between the manufacturer and the user, the test voltage may be maintained for 1 second; then removed. In this case, the test voltage shall be 10 percent higher than the value specified in Table 1.

5.5 Test Requirements — During the dielectric test, no breakdown or flashover shall occur. Other criteria (for example, a leakage current limit) shall be observed when so specified in the relevant electrical relay standard.

5.6 Repetition of Dielectric Tests — For a relay in a new candition, dielectric tests may be repeated, if necessary, to verify its performance, the test voltage value being the specified value.

When dielectric tests are repeated, for example, for final measurement after an endurance test, they shall be made at the reduced values specified in the relevant electrical relay standard.

6. MEASUREMENTS OF INSULATION RESISTANCE

6.1 Measurements of insulation resistance when specified in the relevant electrical relay standard shall be performed in accordance with **4.3.**

6.2 The insulation resistance shall be determined when a steady value has been reached and at least 5 s after applying a dc voltage of about 500 V.

6.3 The insulation resistance so measured shall not be less than that specified in the relevant electrical relay standard.

NOTE — The minimum insulation resistance values may be different for safety purposes and for functional purposes.

7. IMPULSE VOLTAGE TEST

7.1 General — Impulse voltage test shall be performed as type test. General guidance for selection of test voltage values is given in Appendix D.

7.2 Value of Impulse Voltage — Impulse voltage tests shall be made by applying an impulse, the peak value of which shall be chosen from the following values, as specified in the relevant electrical relay standard:

0, 1 and 5 kV (tolerance $^{+0}_{-10}$ percent)

7.2.1 The test in accordance with **4.3**(a) shall be carried out, unless otherwise specified, between each circuit (or each group of circuits having the same insulation) and the exposed conductive parts at the impulse voltage specified for this circuit (or this group of circuits).

7.2.2 The test in accordance with **4.3**(b) between two independent circuits shall be carried out, unless otherwise specified, at the higher impulse voltage specified for the two circuits.

7.2.3 The test in accordance with **4.3**(c) shall be carried out at the impulse voltage specified for the circuit under test.

7.2.4 When zero impulse test voltage is specified, the relay or any of its circuits is exempted from the impulse voltage test.

7.2.5 The test voltage level shall be the open-circuit voltage of the generator before its connection to the relay.

7.3 Waveform and Generator Characteristics—A standard lightening impulse in accordance with IS : 2071 (Part 2)-1976* shall be used.

The parameters are:

a) Front time: 1·2 μs $\pm$ 30 percent; and

b) Time to half-value: 50 μs $\pm$ 20 percent.

NOTE — Tests performed with other waveforms, for example, high-frequency oscillatory waveforms may be specified but such tests are considered to be functional tests and are normally relevant only to static relays.

The recommended standard test circuit and impulse generator are shown in Appendix D.

7.3.1 If an alternative generator is used, it shall have the following characteristics:

a) Output impedance: 500 Ω $\pm$ 10 percent; and

b) Output energy: 0·5 J $\pm$ 10 percent.

7.3.2 The length of each test load shall not exceed 2 m.

7.4 Test Procedure —Impulse voltage tests shall be carried out in accordance with **4.3**. The impulse voltage shall be applied to the appropriate points accessible from the outside of the relay, the other circuits and the exposed conductive parts being connected together and to earth. During these tests, no input or auxiliary energizing quantity shall be applied to the relay. Three positive and three negative impulses shall be applied at intervals of not less than 5 seconds.

7.5 Test Requirements — After the test, the relay shall still comply with all the relevant performance requirements.

NOTE — A flashover (disruptive discharge) which causes no damage is not necessarily a criterion of failure. The manufacturer shall decide whether or not to eliminate the cause, provided other criteria of acceptance are met.

7.6 Repetition of Impulse Voltage Test — In general, the impulse voltage test shall be performed only once on a new relay. If a further test

*Methods of high voltage testing: Part 2 Test procedures (*first revision*).

is required, it shall be performed at 60 percent of the specified impulse voltage.

7.7 The advice on safety measures for operating personnel and surroundings during the test is given in Appendix E.

8. MARKING

8.1 The symbols indicated below shall be used when the marking of the test voltage(s) is specified in the relevant electrical relay standard or when the manufacturer chooses to mark the relay. The marking is also applicable to relays in accordance with **3.4**.

8.1.1 In the absence of marking of the test voltage, the manufacturer should state the insulation level(s) of the relay.

8.2 The symbols for marking of the dielectric test voltage are given in the upper part of Table 2. For test voltages above 0·5 kV, the value in kilovolt is shown inside the star.

TABLE 2 SYMBOLS FOR MARKING OF THE TEST VOLTAGE

(*Clauses* 3.4, 8.2 *and* 8.3)

TEST VOLTAGE (1)	SYMBOL (2)
Dielectric test voltage:	
Test voltage 500 V	
Test voltage above 500 V (for example, 2 kV)	
Relay not subjected to a voltage test	
Impulse test voltage:	
Test voltage 1 kV	
Test voltage 5 kV	
Relay not subjected to an impulse test	

8.3 The symbols for marking of the impulse test voltage are given in the lower part of Table 2.

APPENDIX A

(*Clauses* 0.3, 5 2 *and* B-1 5)

GUIDANCE FOR DETERMINING THE VALUE OF DIELECTRIC TEST VOLTAGE

A-1. For assessment of value of dielectric test voltage, guidance is given in Table 3.

The manufacturer should consider this guidance when designing a relay, taking into account its probable intended use. Likewise, the user may conclude from the series (A, B or C) whether or not a particular relays is adequate for his purpose.

TABLE 3 GUIDANCE FOR INSULATION ASSESSMENT

(*Clauses* A-1 *and* A-2)

Dielectric Test Voltage Series	Decrease of Dielectric Strength Due to Environmental Influences (Inside the Enclosure if the Degree of Protection is Less than IP 50* for Internal Parts)	Stresses on Insulation Due to Spikes and Surges Exceeding the Rated Insulation Voltage	Consequences of Insulation Faults as Related to the Available Power in the Circuit [*see* A-2(b)]
(1)	(2)	(3)	(4)
A	Small	Small	Negligible
B	Medium	Medium	Medium
C	Large	Large	Severe

*'IP 50' is defined in IS : 2147-1962 'Degrees of protection provided by enclosures for low-voltage switchgear and controlgear.'

A-2. The following explanations apply to Table 3:

a) The appropriate series is that the stated conditions of which cover all effects to which the relay will be subjected during operation.

b) Insulation faults in circuits connected to the supply mains or energized *via* measuring transformers should always be considered as resulting in severe consequence.

c) Different series may apply to different circuits of a relay. In this case, the insulation between them should be designed according to the higher series.

A-3. Appendix C gives explanation concerning over-voltage phenomena for assessment of severity of voltage tests.

APPENDIX B

(*Clause* 0.3)

GUIDANCE FOR DETERMINING THE VALUES OF CLEARANCES AND CREEPAGE DISTANCES

B-0. GENERAL — This appendix is intended to serve as a guide for determining the values of clearances and creepage distances.

B-1. In determining the values of clearances and creepage distances, it is recommended that the points given in **B-1.1** to **B-1.5** should be considered.

B-1.1 If a clearance or a creepage distance it interrupted by one or more conducting parts, either one of the sections between these parts should at least be the prescribed minimum value or the sum of the two longest sections should at least be 1·25 times the prescribed minimum value. Individual sections less than X mm* in length should not be taken into consideration in the calculation of total length of clearances and creepage distances.

B-1.2 In determining a creepage distance, grooves at least X mm wide and X mm deep should be measured along their contour. Grooves having any dimension less than those dimensions and any grooves liable to become filled with dust should be neglected and direct distance only measured.

B-1.3 In determining a creepage distance, ridges less than X mm should be neglected. Those at least X mm high are measured along their contour, if they are integral parts of a component in insulating material (for instance by moulding or welding) and along the shorter of the two paths: length of joint or profile of ridge, if they are not integral parts of a component in insulating material.

B-1.4 The application of the foregoing rules is illustrated by the following figures:

a) Fig. 1, 2 and 3 indicate the inclusion or exclusion of a groove in a creepage distance;

b) Fig. 4 and 5 indicate the inclusion or exclusion of a ridge in a creepage distance;

c) Fig. 6 indicates the consideration of the joint when the ridge is formed by an inserted insulating barrier, the external profile of which is longer than that of the inserted portion; and

d) Fig. 7, 8, 9 and 10 illustrate how to determine the creepage distance to fixing means situated in recesses in insulating parts.

*The value of X is under consideration. In the meantime it is proposed to apply for relays $X = 1$ mm.

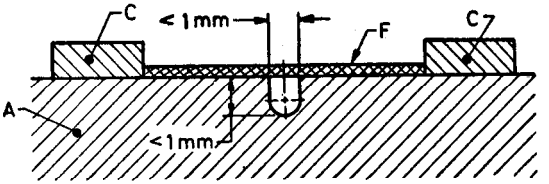

FIG. 1

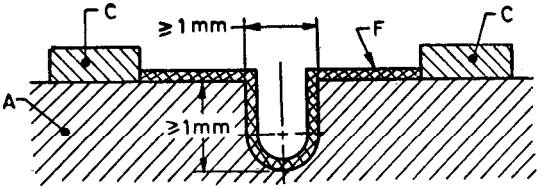

FIG. 2

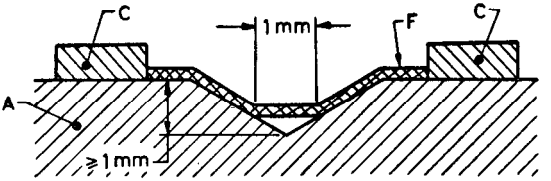

FIG. 3

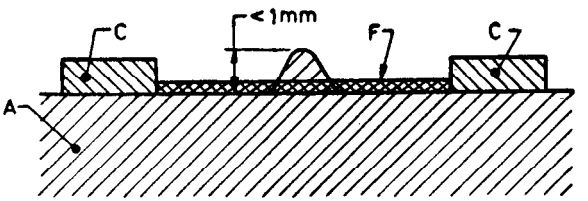

FIG. 4

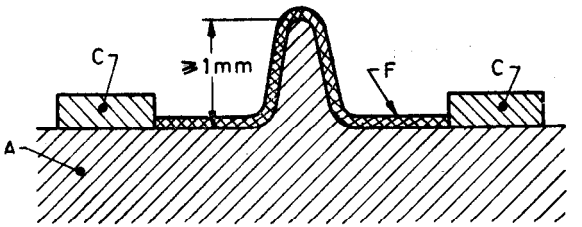

FIG. 5

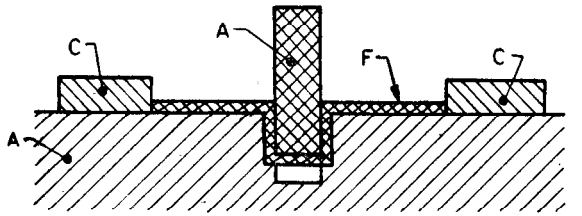

FIG. 6

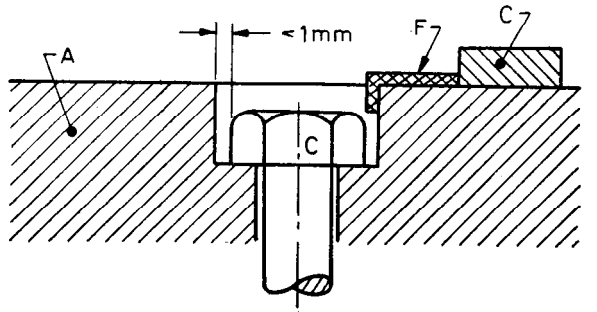

FIG. 7

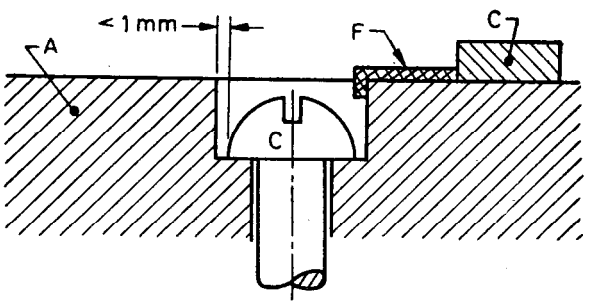

FIG. 8

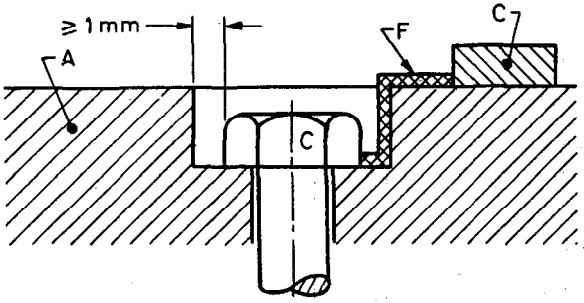

FIG. 9

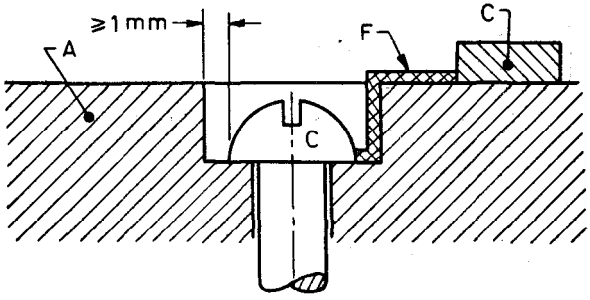

FIG. 10

A = Insulating material
C = Conducting part
F = Creepage distance

FIG. 1 TO 10 MEASUREMENT OF CREEPAGE DISTANCES

B-1.5 For determining values of clearances and creepage distances, guidance is given in Table 4 and refers to the test voltage series in accordance with Appendix A.

B-2. The following explanations apply to Table 4:

a) Values not included are under consideration, pending uniform regulations.

b) For clearance, $L - L$ denotes the minimum values between two live parts and $L - A$ denotes the minimum values between a live part and an exposed conductive part. When the specified clearance $L - A$ is greater than the corresponding creepage distance specified in column (a) or (b), the creepage distance from the live part to the exposed conductive part shall not be less than the clearance.

TABLE 4 GUIDANCE FOR DETERMINATION OF CLEARANCES AND CREEPAGE DISTANCES

(*Clauses* B-1.5 *and* B-2)

Rated Insulation Voltage	Series A			Series B			Series C			
	Clearance	Creepage Distance		Clearance	Creepage Distance		Clearance		Creepage Distance	
		a	b		a	b	*L*–*L*	*L*–*A*	a	b
V	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
30	—	—	—	—	—	—	—	—	—	—
60	0·5	0·5	0·5	1	1	2	2	3	2	3
127	0·5	0·5	1	1·5	1·5	2·5	—	—	—	—
250	1	1	1·5	2	2	3	3	5	3	4
380	1·5	1·5	2	3	3	4	4	6	4	6
500	2	2	3	4	4	6	6	8	6	10
660	—	—	—	—	—	—	—	—	—	—
750	—	—	—	—	—	—	—	—	—	—
1 000	—	—	—	—	—	—	—	—	—	—

c) For creepage distances, the values given in columns (a) and (b) are applied in conjuction with the shape of the creepage path and the comparative tracking index of the insulating material in accordance with IS : 2824-1975*.

d) Guidance for determination of the applicable column is given in Table 5.

TABLE 5 GUIDANCE FOR DETERMINATION OF CREEPAGE DISTANCES
(*Clause* B-2)

Comparative Tracking Index of Insulating Materials	Minimum Creepage Distance for a Creepage Path	
	Without Ridges	With Ridges
From 120 up to and including 174	b	$\frac{a+b}{2}$
From 175 up to and including 400	$\frac{a+b}{2}$	a
Over 400	a	a

B-3. Unless otherwise specified in the relevant relay standard or unless agreed between the manufacturer and the user, clearance and creepage distance requirements do not apply to relays or parts of them which are adequately protected from dust. An adequate protection may be assumed with relays having a degree of protection of at least IP 50, in accordance with IS : 2147-1962†.

APPENDIX C
(*Clauses* 0.3 *and* A-3)

EXPLANATIONS CONCERNING OVERVOLTAGE PHENOMENA

C-1. Overvoltages beyond the rated voltage and which may need to be considered for the assessment of the severity of voltage tests are as follows:

a) The highest voltage of the system is the maximum value which occurs under normal operating conditions at any time;

*Method for determining comperative tracking index of solid insulating materials under moist conditions (*first revision*).

†Degrees of protection provided by enclosures for low voltage switchgear and controlgear.

b) Temporary voltage variations are those at power frequency or dc which may be assumed to occur up to some minutes; and

c) Voltage transients, such as those resulting from system switching, which are of short duration of the order of milliseconds or micro-seconds.

C-2. Overvoltages may cause breakdown or premature ageing of insulation, or may interfere with the function of the relay, depending upon their magnitude, their shape or frequency, their duration and upon the points of relay where they occur. Regarding the latter, a distinction is made between:

a) overvoltages which occur between the conductors of one circuit,

b) overvoltages which occur between different circuits, and

c) overvoltages which occur between the conductors and parts of one circuit together to earth.

APPENDIX D

(*Clauses* 7.1 *and* 7.3)

GUIDANCE FOR IMPULSE VOLTAGE TESTS

D-1. RECOMMENDED IMPULSE VOLTAGE FOR GENERATOR ASSEMBLY

D-1.1 For generation of impulse volsages as specified in **7**, an assembly as shown in Fig. 11 and consisting of components as given in Table 6 is recommended.

TABLE 6 COMPONENTS OF IMPULSE VOLTAGE ASSEMBLY

Test Voltage	R_1*	R_2*	C_1*	C_2*
kV	kΩ	kΩ	μF	nF
(1)	(2)	(3)	(4)	(5)
1	0·08	0·5	1·0	0·8
5	1·80	0·5	0·035	0·8

*Tolerances for the value of each component shall be ±1 percent.

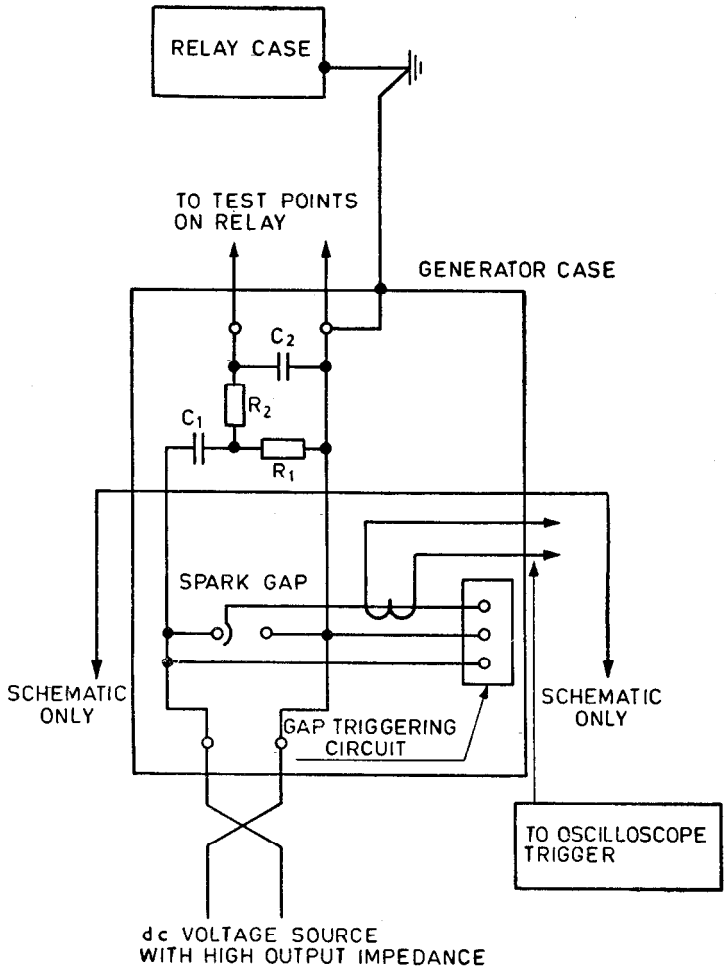

FIG. 11 RECOMMENDED ASSEMBLY FOR GENERATION OF IMPULSE VOLTAGE

D-2. RECOMMENDED APPLICATION OF TEST VOLTAGES

D-2.1 Relays Exempted from Impulse Voltage Test — Relays which are exempted from the impulse voltage test may be used as part of protective equipment, as it is not necessary to apply a withstand test voltage to

the relay since the equipment will be tested in acordance with the relevant specification.

D-2.2 Relays to be Tested with 1 kV — Relays or relay circuits tested with 1 kV may be used where:

a) the auxiliary circuits (power supply circuits) of the relay are connected to a voltage supply used exclusively for the power supply of static relays. If the leads are short, and in the absence of switching on other circuits connected to the supply, the levels of transient voltage on the supply leads will be low (less than 1 kV);

b) the input energizing circuits of the relays are not connected directly to instrument transformers or where good screening and earthing is employed on the connecting leads;

c) the output circuits are connected to a load by short lead lengths; and

d) normally, no voltage test is required but an extra-high security is desirable.

D-2.3 Relays to be Tested with 5 kV — Relays or relay circuits tested with 5 kV may be used where:

a) the auxiliary energizing circuits (power supply circuits) of the relay are connected to a common battery, etc. Due to the long lead lengths, longitudinal transient voltages of a relatively high value may appear on the supply leads and transverse voltages may arise from switching in other circuits connected to the same battery or supply source;

b) the input energizing circuits of the relay are connected to instrument transformers and/or where long lead lengths are involved and no effective screening and earthing is employed;

c) the output circuits are connected to a load by long leads with the result that longitudinal transient voltages of a relatively high value may appear at the output terminals; and

d) normally, a lower test voltage in terms of **3.2** is sufficient but an extra-high security is required.

NOTE — A relay may have different test voltage for its input energizing circuits, auxiliary energizing circuits and output circuits.

APPENDIX E

(*Clause* 7.7)

ADVICE ON SAFETY MEASURES

E-1. Insulation tests and adequate dimensioning of clearances and creepage distances contribute to the safety of the operating personnel and the surroundings; however, particularly for relays to be operated at voltages exceeding extra-low voltage and not to be contained within cubicles and the like, further safety measures shall be taken.

E-2. Further guidance on safety aspects in electro-mechanical relays may be followed according to IS : 9249 (Part 1)-1979*.

E-3. The safety aspects in static protection relays should be followed as stated by the manufacturer.

*Safety requirements for indicating and recording electrical measuring instruments and their accessories: Part 1 Common safety requirements for instruments.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volts	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2